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KAREN BARAD AND QUANTUM THEORY

GENERICSCIENCE CUT, DERRIDA, FIELD, GÖRNITZ, QUANTUM THEORY, VACUUM

For quantum physicist Karen Barad, reality is one of entangled phenomena that always obey quantum laws. (Barad 2007: 118 ff.) Each phenomenon comprises its own past and future, which are then created as times as soon as the coordinates of a phenomenon are determined by an acting cut in physical measurement qua material discursive apparatuses. [1] For Karen Barad, who cites Niels Bohr as a reference at this point, the term “phenomenon” refers to registered observations or measurements, i.e. only to what has already happened and not to what could happen in the future, even if the latter possibility corresponds to a prediction that is indeed made possible by quantum mechanics, but can only be probabilistic and therefore can never guarantee an exact result. (For probabilistic thinking, the total number of possible cases or the total range of possible outcomes, each with its determinable probability of

occurrence, must be finite and countable. This applies to negentropic as well as entropic processes, whereby negentropy accordingly quantifies and makes countable the symmetrical negative of what the term “entropy” quantifies and makes countable).

Whoever measures waves does not measure particles at the same time and whether one observes a field or a particle depends on an already technically mediated question. Values of complementary variables (such as position and momentum) are not simultaneously determined. If the position of a particle is well-defined, its momentum exists in an indeterminate state of pure potential – an ontologically indeterminate uncertainty of potential momentum – and vice versa. If your first measurement M1 at time t1 is a measurement of a position, then Born's rule can be used to make predictions about the probability or statistics of a future position measurement at any future time tn, but no predictions can be made about future momentum measurements at any future time. If one then makes a pulse measurement M2 at time t2, previous predictions about the position measurement become meaningless because they are no longer verifiable, and any new measurement excludes any prediction about future position measurements. One can make predictions about future momentum measurements, namely the value of the momentum with a certain probability within a certain range. (Plotnitsky 2012) A measurement generally represents an interaction that contextualizes a quantum system so that a certain set of properties can be determined, which at the same time implies that a new system is created in which other properties are undetermined. A further measurement constitutes a different catalog of future expectations that ties in with the previous measurement and the generated horizons of expectation. In this way, a successive progression from measurement to measurement, from observation to observation is possible, whereby a new ψ -function is created from one step to the next. Plotnitsky argues that the interaction between the object and the measuring instrument, which leads to entanglement, is not yet a measurement in the sense that it leads to an observable quantity: This interaction takes place before the measurement occurs or before the result of this interaction is registered as a quantum phenomenon. There is the constitution of reality, which is responsible for quantum phenomena, quantum objects (idealizations at the time of measurement), measuring instruments and quantum phenomena (defined by what is observed in measuring instruments). For Plotnitsky, in the case of quantum phenomena, there is technically a difference between an observation that constructs a phenomenon and a measurement that measures physical properties of that phenomenon. (Plotnitsky 2021) A quantum measurement only establishes a quantum phenomenon when it manifests itself as a result in a measuring device. What is registered is either the change in the momentum of certain observed parts of the device or the position of one or another trace of the interaction, possibly a spot on a screen. (Plotnitsky 2021) Each measurement establishes the only fact that exists, and an alternative measurement would establish a different fact.

Before the measurement there are only (positive potentials), but no facts or results. We also do not know what takes place between the measurements. Quantum systems are therefore not objects that we find in reality. They are relational relationships or potential spaces that can lead to results based on further relationships, those of the measurement. Probability functions or those of the wave function therefore only represent (objective) tendencies that are updated discontinuously or by quantum leaps through subjective observations or measurements. This is how the connection between the functions and reality takes place. Measuring devices have

an unobservable quantum layer that enables interaction with the part of this layer that is assumed to exist independently, without being able to represent it, as would be the case in a realistic understanding. Consequently, for Plotnitsky, quantum phenomena are irreducibly different from quantum objects, although they can represent classical objects associated with measuring instruments. Phenomena involve both the description of an experimental arrangement and the observed results.

Each phenomenon entails a specific difference, a cut that juxtaposes an agent and an object in the measurement process that cannot be organized without apparatus. (Barad 2007: 118 ff.) The cut between the object and the measuring device is arbitrary in principle, although in practice it depends on the technologies of the experiment. The cut can be continued ad infinitum either between the original object and the instrument or between the composite object and another instrument. The intraactions between the inside and the outside lead to a changing complementarity, which is the core of Bohr's economy of matter or mind. From one logical place the particle description applies, from another place the wave description. Both descriptions are not reducible to each other, but their incompatibility cannot be thought of as a falsification of the other description either. Both and or complementarity apply. Bivalence is replaced by multivalence.

It can be said that the cut involves an observation, or rather a measurement, in order to learn something about the observed entity. The measurement will always have a certain influence on what is measured. Indeterminacy always influences the interaction and thus the possibility of a sharp distinction between the measured object and the measuring instrument, since both must be treated as quantum systems. The concept of intraaction in Barad's sense implies that both the observer and the observed objects do not precede an interaction, but only arise with it. Subject and object are not absolutely distinguishable from each other, but can only be separated from each other with regard to moments of the respective entanglement and relation in the experiment and of knowing and not knowing. The concepts of subject and object become blurred, as only in a particular observation constellation is it clear who is the observer and what is the observed, whereby the accompanying cut emerges from a concrete practice of observation. At the same time, the observer and the observed must appear as a unit and thus we are dealing with a conditioned co-production (decontextualized, there are neither subjects nor objects).

However, no cut can erase the blurring relations, unless one returns to the classical boundaries, where the observed object and the measuring device can be regarded as separate. At the same time, the cut is sufficiently determined by the experimental arrangements so that the results are sufficiently independent of any particular observer – a fact that Bohr repeatedly emphasizes and which for him seems to define the objective character of quantum mechanics. Bohr's complementarity thus slowly moves away from the subject and becomes anti-subjectivist, since it is at least incompatible with the (metaphysical) category of the subject. Going further, if one prefers the object side, one must assume that a measurement in a quantum physics experiment also leads to a result if no one is observing (decoherence).

The problem of the observer can lead to an infinite regress of observers. John v. Neumann shows that the observer (this can be measuring equipment and the sensory organs of the researcher) can itself be described in terms of quantum theory. The observer is thus relevant for research practice, but no more than an entity that stands outside the research processes to be investigated. If the measurement process can be described quantum mechanically, then there is no observer in the world that can generate an exact intersection and collapse of the wave function.[2] Thus, following the realist position, the problem arises that interference cannot be explained on the basis of wave equations, since these calculations are based on imaginary numbers and negative probabilities. (Vogd 2014: 334) With Heisenberg, a middle way can be taken. On the one hand, an observer causes the wave function to collapse, which is to be understood as a transition from the possible to the factual; on the other hand, the observation process is physical and not psychological in nature. However, if wave functions do not collapse, every step must be made arbitrarily with von Neumann. Schrödinger's wave function can then be regarded as objectively physical at the same time. However, probability cannot be directly linked to mass or energy.

The constantly shifting cut simultaneously problematizes the concept of your independent physical reality and complicates the possibility of creation on the one hand and of disturbance through observation or measurement in quantum physics on the other. So you can neither speak of a creation of quantum events by an experiment nor of independent or undistorted quantum objects. If one were to do so, there would be undistorted and intrinsic properties of the objects that would be independent of interpretation and interaction. For Bohr, this would imply a metaphysical reality that would replace the radical alterity of the general quantum economy. However, the limits of this measurement process must also be recognized here[3]: "However, good science also consists in deciding when one can ignore an undetectable influence with a clear conscience. For example, no experiment will be able to determine what influence it has on the moon whether I look at it or not, although according to the theory such an influence must exist" (Görnitz/Görnitz 2016: 27). The moon is undoubtedly out there, but its relationship to the sciences is not complementary or of mutual determination, but rather one of destructive interference, of mutual indeterminacy.

The "background" of the plurality of phenomena is the void or vacuum, pure quantum potentiality. (Barad 2007: 354) The term background indicates that the "laws of nature" produced by the technical relation are to be relativized in their objectivity insofar as nature here is the result of an already specific technical relation in and with which it is observed and thought. However, nature cannot be reduced to the effect of the technical relation. Nature reveals indeterminacy. It is an uncapturable surplus whose fundamental nature cannot be represented. Natural phenomena can only be determined by means of a specific theory and technique that is used to observe them.

According to Karen Barad, quantum reality therefore only exists within a phenomenon that is the result and part of an intra-activity of different components (to speak of interaction is already a concession to classical ontology, because it implies that separate parts somehow interact), in which a cut is made in the experiment and the object is fixed as observed. (Barad 2007: 234f.) The cut isolates the "object" (particle) and the mark in the measuring device, so that a change or a difference in the object is intertwined with a change in the apparatus. Bohr

has already shown that objectivity here by no means presupposes a Cartesian cut between particles; rather, it is about the intra-active staging of a cut (determined by the experimental set-up) that separates (and connects) the non-classical “object” from the observation points, whereby a reproducible and unambiguous measurement of a part of the phenomenon becomes possible. [4] (Ibid.: 97 ff.) The phenomenon is then that which is measured as a trace or effect at a certain point, but whose effectiveness can never – neither in the past nor in the present nor in the future – be regarded as present. This loss of presence makes quantum-theoretical economy a general economy (Bataille) and relates its efficacy to Derrida’s trace and alterity.[5] At this point the measurement problem arises, the observation itself, insofar as the transition from the continuous wave function to the numerical measurement value of quantum mechanics cannot be specified. John Neumann attempted to solve the problem through several iterations between observer and observed.

In the extension of the Copenhagen interpretation, Görnitz shows that one effect of the measurement process is that, in addition to the measurement result, which must be regarded as a fact, information about quantum possibilities disappears from the measured system. The measurement process involves the loss of quantum information about the quantum possibilities of the measured system, which are lost except for the remaining fact. Nevertheless, new possibilities are opened up at the same time. (Görnitz/Görnitz 2016: 411)

The intraaction that takes place as a measurement cannot be understood as an attribute or in the context of subjects or objects (since these do not exist as such in the experiment). The cut is sufficiently determined only by the experimental arrangements or the material-discursive apparatus, as Barad writes, so that the results obtained are initially independent of a *specific* observer – a fact that Bohr repeatedly emphasizes and which for him defines the “objective” character of quantum mechanics. Ultimately, however, the entities in the measurement process can no longer be clearly separated from the observer. A philo-techno-epistemic momentum is inscribed in quantum theory. The epistemic, ontological and technical moments of science should not be mixed, but rather examined in their complementarity. Questions about “what is” (ontology) and “what can we know” (epistemology) can be shifted in order to obtain a certain result, depending on how the question is posed. One can no longer assume a clear boundary between observer and observed, as in *objectivism*, when both moments are in a non-trivial recursive relationship with each other. At the same time, unlike *subjectivism*, one cannot assume *that* it is only the observer who decides what he observes.

Even quantum theory does not escape the structure of all previous theories in which time is defined. First the state of the system, then the observation, which in turn induces dynamics and time. Instead of understanding the sequence of time as a continuous sequence of points in time, however, time itself would have to be understood in a fuzzy way, which means that the ontological structure that quantum physics is also looking for in a unified theory does not follow the division into these quantities. In time, systems that are in intra-action use part of their knowledge or information to define relations, whereby the entanglement of the systems has negative consequences, namely the destruction of the knowledge of the systems involved. Contingency is the consequence, which can lead to a new assignment of variables

of the system. There is a successive process, neither erratic nor continuous, in which new contingencies are constantly produced via intra-action. In a constant context in a quantum system, one value remains determined and another undetermined. The determination of one value leaves the other undetermined.

[1] Deleuze's distinction between chronos as the pure present and aeon as the place of the past and future as well as of incorporeal events goes even further. For Deleuze, the incorporeal resides in the past and the future (aeon) as well as in transformative possibilities. The incorporeal lies in the verb, in the attribute of the cut, and not in the physical presence of the cut itself. Deleuze states a distinction between being cut and the attribute of being cut, whereby the latter is not identical with the cut body. The second incorporeal cut could be seen as reversible, since the cut is not irreparable.

[2] In this context, Plotnitsky establishes a connection between Bohr's theory and Bataille's general economy, in which the non-utilizable surpluses of material energy are created and destroyed by alterity effectiveness. These surpluses cannot be fully utilized by any subjective process that employs material resources, regardless of whether materiality is defined in terms of physics, biology or history. (Plotnitsky 1994: 116)

[3] Baudrillard attributes to the world a dissidence that in its paradox defies even the laws of physics. The more we approach the object through experimentation in the course of scientific progress, the more it eludes us. Baudrillard writes: "We cannot invoke the pretext of an insufficient development of the scientific, intellectual and mental apparatus. The apparatus has given all it can give; it has even gone beyond its own definitions of rationality" (2000:79-80).

[4] Bohr speaks of the holistic nature of the experimental arrangements of quantum mechanics, which include the interactions between the "objects" and the measuring instruments. Effects that are neither to be understood as absolutely Kantian separated nor as Hegelian completely unified. The intersection between the object and the observing or measuring device is in principle arbitrary, although in practice it depends on the technologies of experimentation. These intraactions induce a changing complementarity, which for Plotnitsky represents the core of Bohr's economy of matter (or mind). (Plotnitsky 1994) Plotnitsky identifies three technologies, a), the experimental technology of particle accelerators, b) technologies of physical, scientific and philosophical concepts used in classical, relativistic and quantum physics, and c) the mathematical technology of quantum theory. (Plotnitsky 2021)

[5] In both quantum mechanics and Derrida's deconstruction, nothing, neither among the elements nor within the system, is simply present or purely absent. There are only and everywhere differences and traces of traces. The trace thus expresses an episteme that operates with displacement. One cannot immediately grasp the event that generates the trace, only in its posteriority. This means that difference and recursion.

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